Photon Detector R&D at IU for TallBo2 & 35 ton Test

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Objectives:

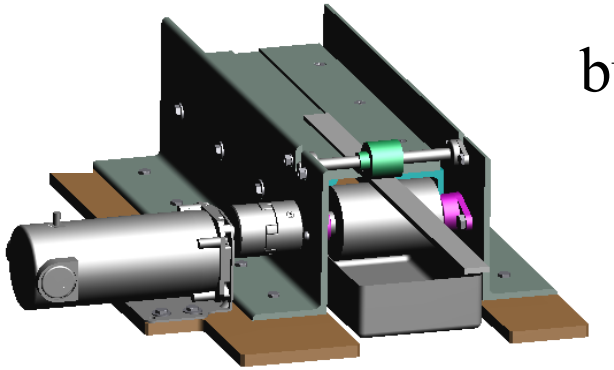
1. TallBo2 & 35 ton test: Test multiple light guide technologies
2. TallBo2: Test Argonne electronics with twisted-pair cables
3. 35 ton test: Test multiple light guide technologies;
   Test calibration scheme(s)

Light Guide Technologies:

- IU technologies
  - flash-heated bars with 35 coats of TPB and bis-MSB
  - cast acrylic bars with 1% TPB (Astra Products)
  - cast acrylic bars with 1.2% TPB (max concentration, commissioned)
  - cast acrylic bars with 1% bis-MSB (commissioned)
  - roller coated bars

Light Guide Technologies:

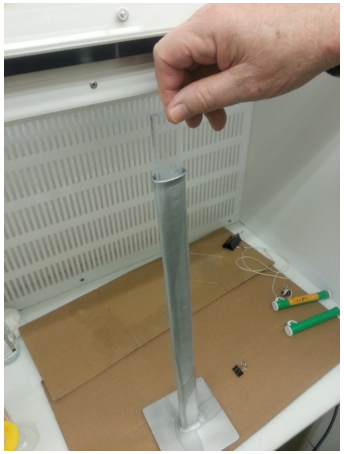
built!



- IU technologies
  - roller coated bars

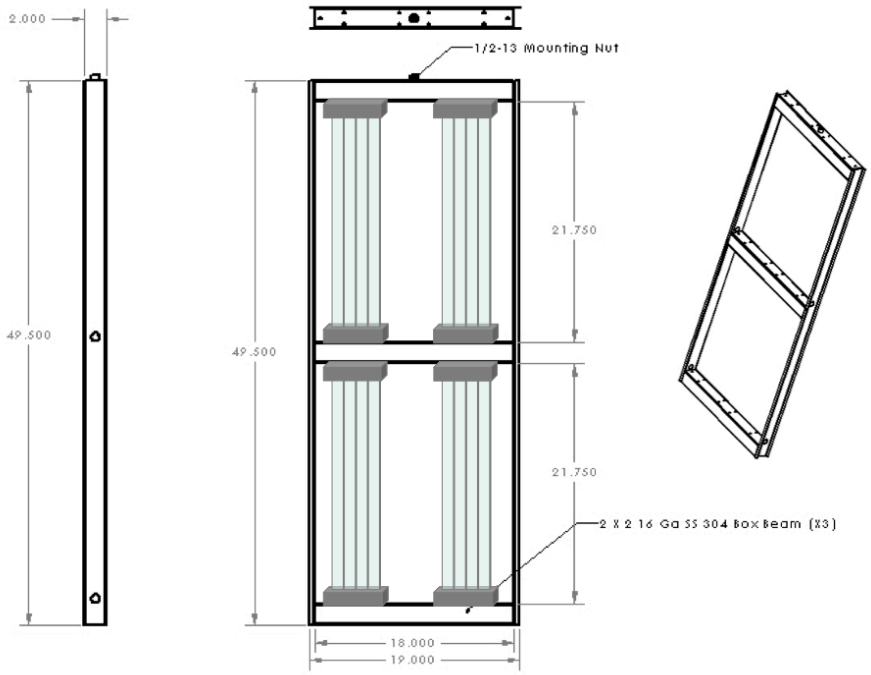
  (technology not yet ready, for TallBo2 run)

- MIT hand-dipped technology with TPB on acrylic blanks from IU



- CSU polystyrene extruded fiber technology with TPB
- LBNL cast polystyrene technology with embedded 1% TPB and 1% bis-MSB (Eljen)

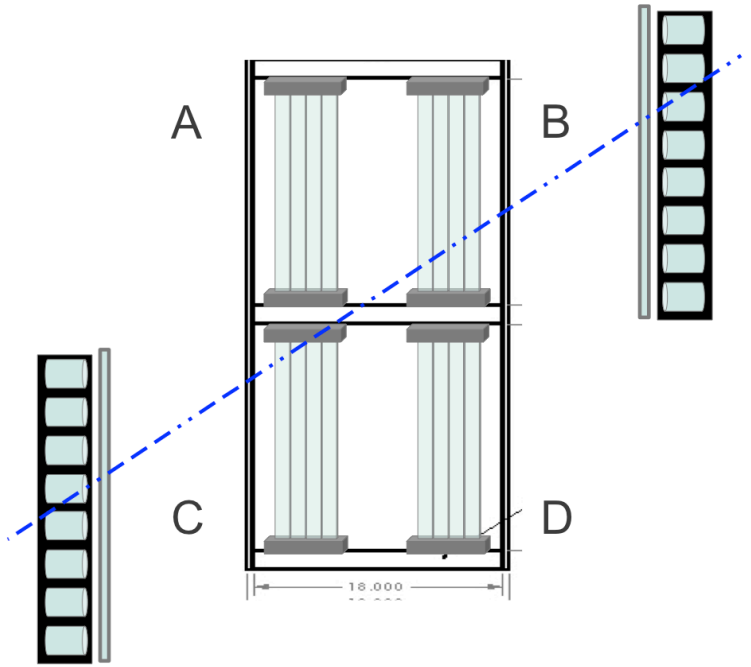
TallBo2



LAr dewar in PAB at Fermilab

- 6’ x 22”, 500 l capacity
- capacity for 4 paddles/16 light guides
- LAr recycling and purification system

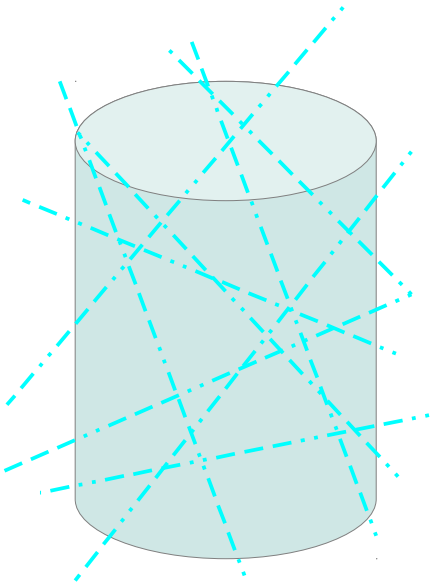
CREST hodoscope paddles to define cosmic track parameters



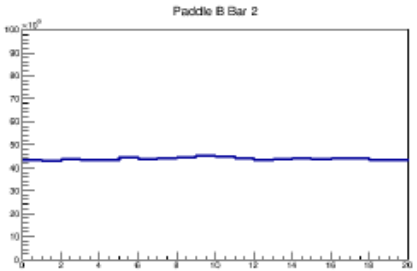
- Two 8 x 8 arrays of PMTs with BaF_2 crystals coated with TPB
- plastic scintillator paddles on both sides
- 4-fold coincidence trigger: 1 PMT + 1 paddle on each side

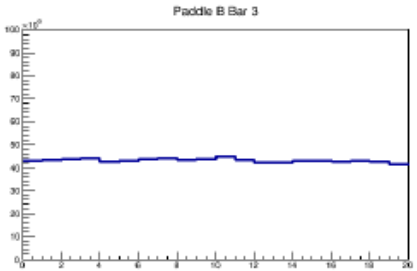
How do we test bars in TallBo? That is, how do we determine which bars function best?

"Free run" mode: self triggered, OR of all SiPMs in paddle

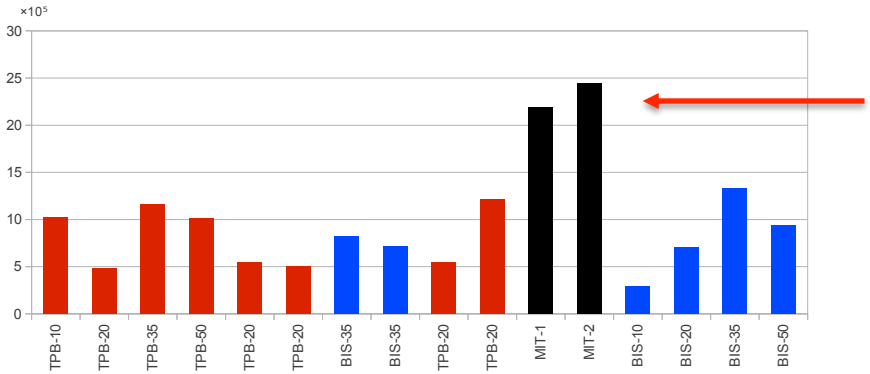


All bars see same distribution of scintillation photons from cosmics (MC of random bars in TallBo)





Results:



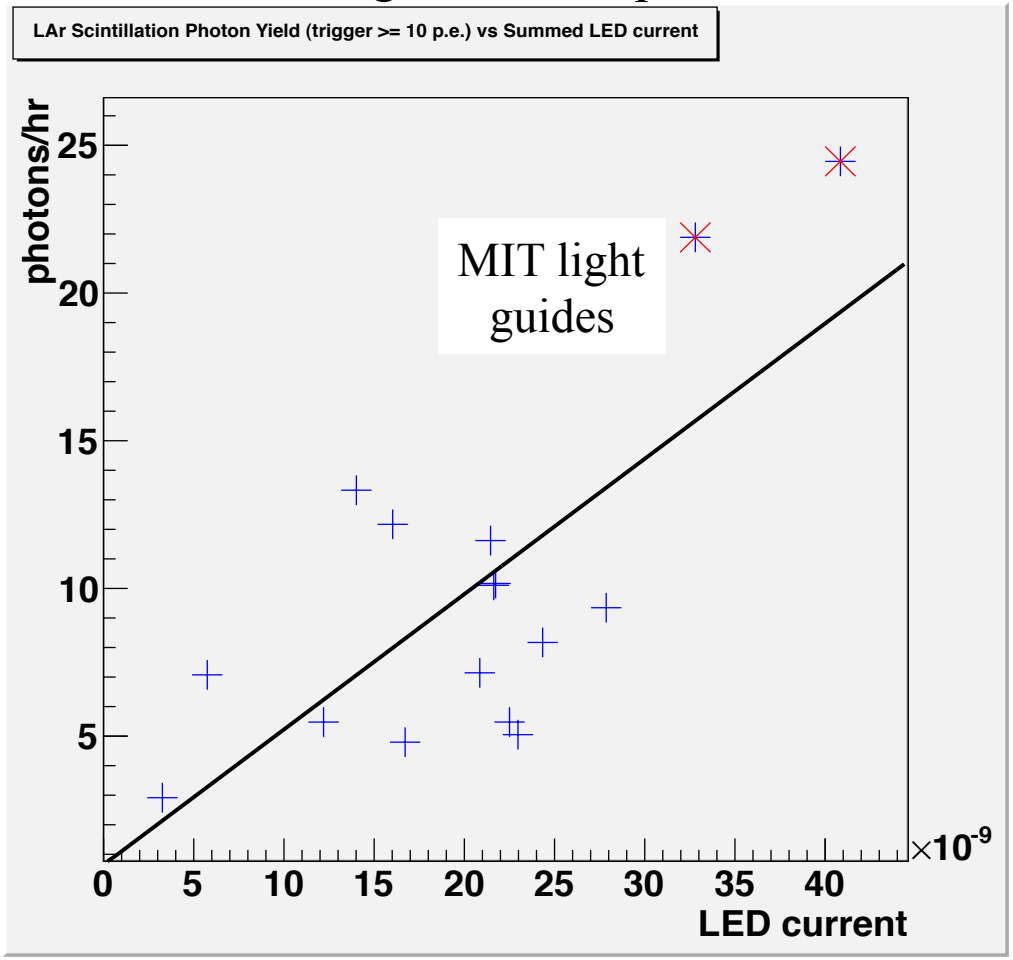
MIT bars are brightest in LAr

It is very time- and resource- intensive to test light guides in LAr

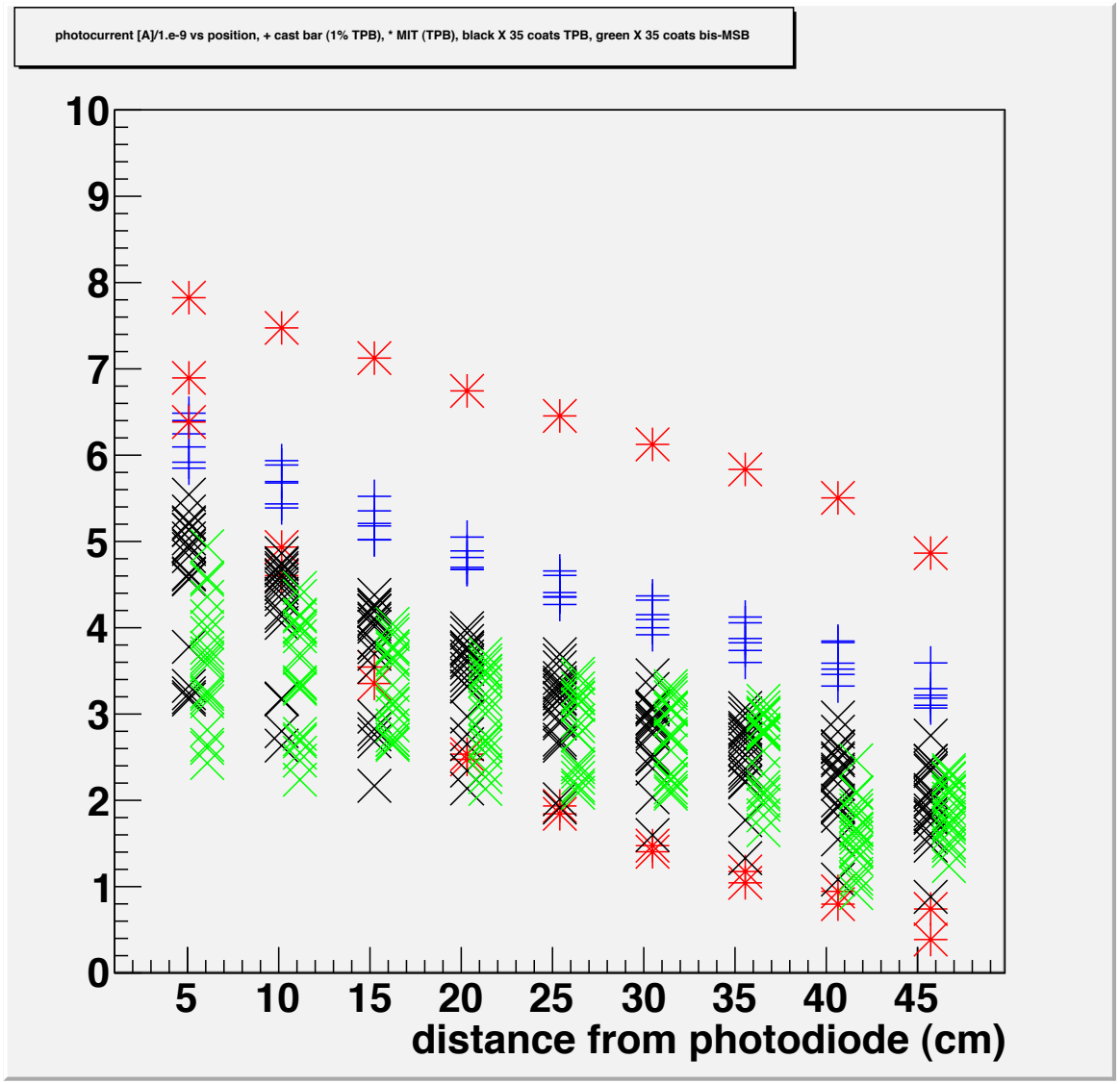
Test bars at room temperature at 245 nm in dark box

Dark Box with computer controlled LED travel viewed by SiPM

efficiency of bar in LAr correlated with integrated LED photocurrent

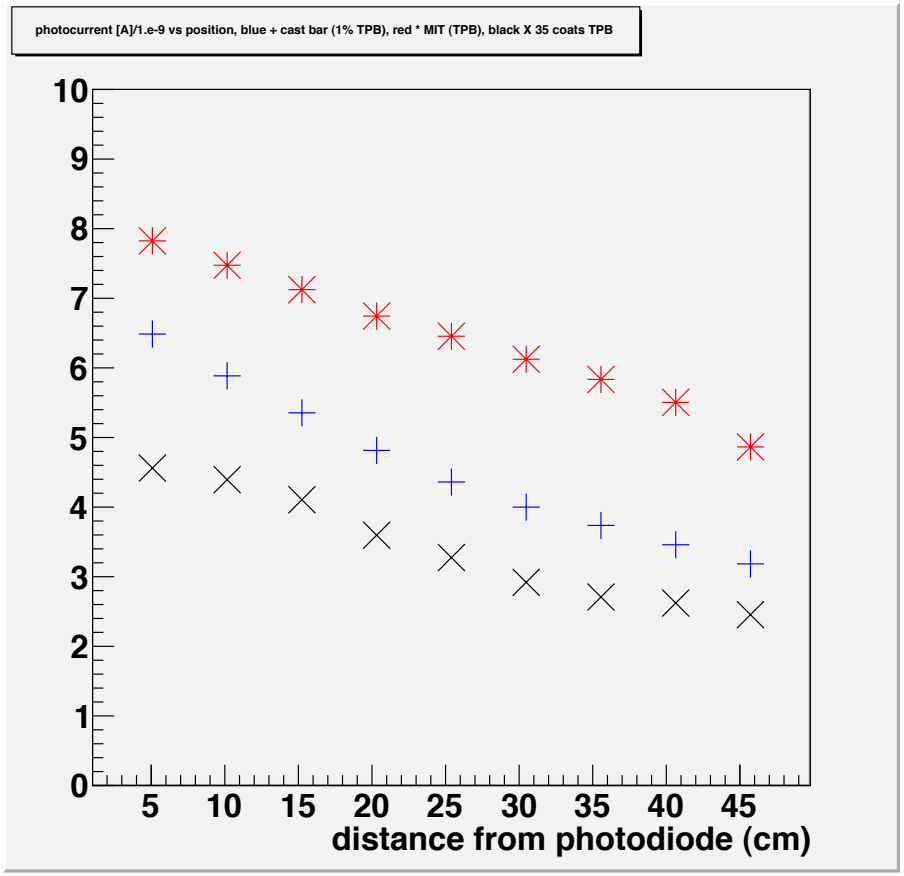


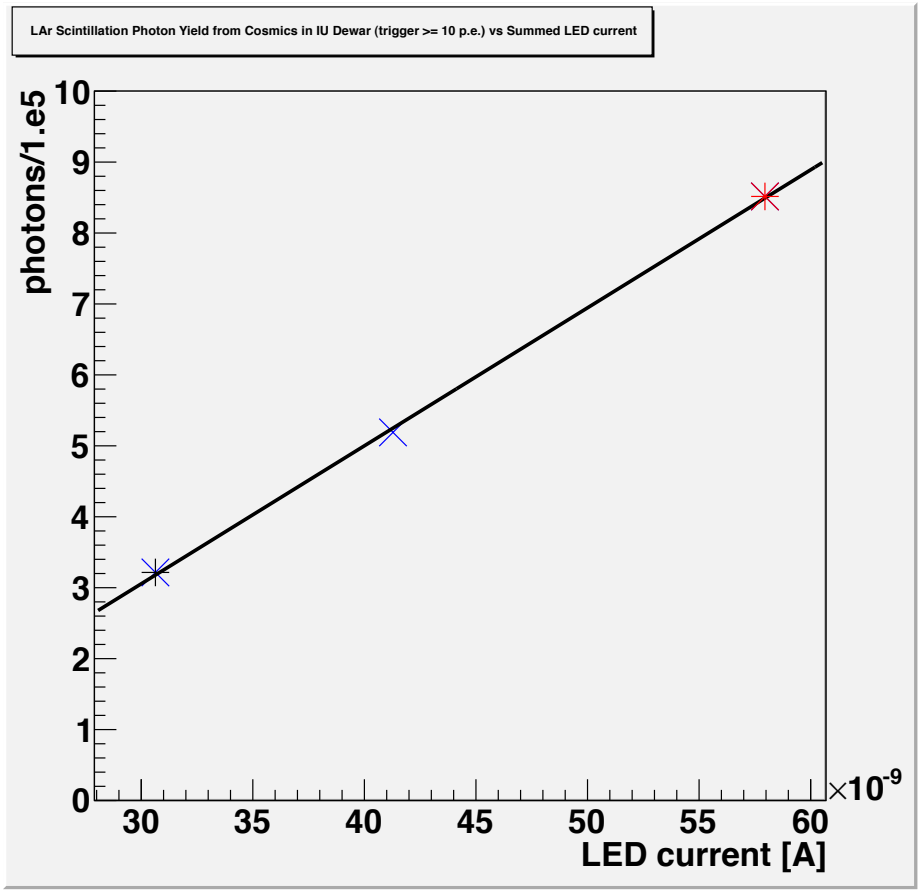
IU & MIT light guides measured at 245 nm in dark box



brightest light guides at 245 nm manufactured with 3 technologies

output at 245 nm correlates with LAr scintillation light from a “free run” in the IU dewar





Current schedule:

TallBo2: IU, MIT, CSU, LBNL technologies

- setup week of 2/24
- run weeks 3/3 & 3/10
- tear down/go home week of 3/17

1) Briefly summarize the current state of the program, discussing what has been learned and what are the remaining issues.

These issues have been addressed in our presentations

2) What is the proposed scope of the R&D program for the next two years, and what resources are required for that program?

We will be running in TallBo in February 2014. We hope to return October – November 2014. There will be a technology down-select for the LBNE photon detection system in 2016, which leaves the opportunity for more testing at TallBo until then. So far the LBNE Project has been willing to fund these activities.

3) Compare the program with similar programs worldwide.

There are photon detector R&D projects at MIT, Colorado State, and Los Alamos in the US. There is work going on in Italy but I do not know much about it

Are we doing leading work in this area?

Yes

4) Which parts of the program should be considered generic R&D and which parts should be considered project specific?

Hard to say. Photon detection is important to many experiments using liquid noble elements. There is no reason, for instance, that these detectors couldn't be used in LXe. Actually the waveshifters TPB and bis-MSB have greater absorptivity in LXe than LAr. On the other hand, this R&D is aimed specifically at LBNE and is being funded for that project. Since we plan to publish our results, other experiments could easily use this work.

5) Will this research likely result in new projects at the lab?

Surely. As liquid noble elements become more wide-spread in HEP as the detector medium, the added physics benefits will lead to increased use of photon detection.